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23. Proposed by H. C. Whitaker, Professor of Mathematics, Manual Training School, Philadelphia, Pennsylvania.

A rectangular hall 80 feet long, 40 feet wide and 12 feet high has a spider in one corner of the ceiling. How long will it take the spider to crawl to the opposite corner on the floor if he crawls a foot in a second on the wall and two feet in a second on the floor?

24. Proposed by Mrs. Mary E. Hogsett, Danville, Kentucky.

On January 4, 1889, it was noticed that a clock was 15 minutes fast. On March 1, 1894, it was found to be six and one half minutes slow. When and what time was accurate time?

Solutions to these problems should be received on or before July 1st.

ALGEBRA.

Conducted by J. M. COLAW, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS TO PROBLEMS.

11. Proposed by ISAAC L. BEVERAGE, Monterey, Virginia.

Two men, *A* and *B*, had a money-box, containing \$210, from which each drew a certain sum daily; this sum being fixed for each, but different for the two. After six weeks, the box was empty. Find the sum which each man drew daily from the box, knowing that *A alone* would have emptied it five weeks earlier than *B alone*,

I. Solution by W. L. HARVEY, Portland, Maine.

Let $x=$ amount B drew out daily, $mx=$ amount A drew out daily.

Then, $\frac{210}{x}-\frac{210}{mx}=35\ldots(1)$, and $\frac{210}{x(m+1)}=42\ldots(2)$.

Solving $m=1\frac{1}{2}$, whence $x=\$2$, and $mx=\$3$.

II. Solution by P. S. BERG, Apple Creek, Ohio.

Let $x=$ what A drew out daily, $y=$ what B drew out daily.

Then, $42x+42y=\$210\ldots(1)$, and $\frac{210}{y}-\frac{210}{x}=35\ldots(2)$.

Whence $x=3$, and $y=2$. $\therefore$ A drew out daily \$3, and B \$2.

Also solved by *M. A. GRUBER, H. W. DRAUGHON, H. C. WHITAKER, C. E. MYERS, G. B. M. ZERR, A. L. FOOTE*, and *ROBERT J. ALEY.*

12. Proposed by F. M. SHIELDS, Coopwood, Mississippi.

Three Lads, *A*, *B*, and *C*, each climbed to the top of an upright pole: *A*'s pole was 20 feet high, *B*'s 60 feet, and *C*'s pole was 100 feet high. They all started at the same time, and each climbed up a part of the way, at the same rate of speed per minute, and after each rested five minutes, they ascended to the tops of their respective poles, at the same rate of speed per minute, when they found that each had consumed the same length of time, 25 minutes each, (including the 5 minutes each rested on the way). How far up did each climb before resting? At what rate of speed per minute did each climb?

Solution by M. A. GRUBER, A. M., War Department, Washington, D. C.

The time of ascent *before* resting *plus* the five minutes' rest *plus* the time of ascent *after* resting $=25$ minutes. ∴ The time of ascent *before* resting *plus* the time of ascent *after* resting $=20$ minutes.

Let $x=$rate of speed per minute *before* resting,
$y=$ " " " " " *after* " ;
$m=$time, in minutes, of A's ascent *before* resting,
$n=$ " " " " B's " " " ,
$p=$ " " " " C's " " " ;
$20-m=$ " " " " A's " *after* " ,
$20-n=$ " " " " B's " " " ,
$20-p=$ " " " " C's " " " .

$mx+(20-m)y=20$, or $m(x-y)=20-20y$, (1).
$nx+(20-n)y=60$, or $n(x-y)=60-20y$, (2).
$px+(20-p)y=100$, or $p(x-y)=100-20y$, (3).

Subtracting (1) from (2), and (2) from (3),

$(n-m)(x-y)=40$, or $x-y=\dfrac{40}{n-m}$, (4)

$(p-n)(x-y)=40$, or $x-y=\dfrac{40}{p-n}$, (5).

From (4) and (5),

$\dfrac{40}{n-m}=\dfrac{40}{p-n}$, or $p=2n-m$, (6)

Adding (1) and (2),

$$(n+m)(x-y)=80-40y, \text{ or } x-y=\frac{40(2-y)}{n+m}, \ (7).$$

From (4) and (7),

$$\frac{40(2-y)}{n+m}=\frac{40}{n-m}, \text{ or } 2-y=\frac{n+m}{n-m}, \text{ or } y=2-\frac{n+m}{n-m}, \ (8).$$

From (8) we observe that when $\dfrac{n+m}{n-m}=2$, $y=0$; when $\dfrac{n+m}{n-m}>2$, y is *negative*; and when $\dfrac{n+m}{n-m}<2$, y is *positive*.

Put $n=m+c$; then $\dfrac{n+m}{n-m}=\dfrac{2m+c}{c}$, $y=\dfrac{c-2m}{c}=1-\dfrac{2m}{c}$, $p=2n-m$ $=m+2c$, and, from (4), $x=\dfrac{40}{n-m}+y=\dfrac{40}{c}+y$, or $x=\dfrac{40-2m}{c}+1$.

Since, for positive values of y, $\dfrac{n+m}{n-m}<2$, then $\dfrac{2m+c}{c}<2$; whence $c>2m$. We also find $n>3m$, and $p>5m$.

As $c>2m$, y is always a proper fraction, except when $m=0$; then $y=1$.

20 minutes is the greatest amount of time that can be consumed in actual ascent. It will readily be seen that p *alone* may equal 20, and that 20 is the greatest value p can have for *positive* values of all times of ascent.

Substituting 20 for p in $p=m+2c$ and $p>5m$, we have $m+2c=20$ and $5m<20$; whence $c=10-\frac{m}{2}$ and $m<4$.

It is, therefore, seen that the limits for m are $m=0$ and $m<4$, and that c is found between $c>2m$ and $c=10-\frac{m}{2}$. By putting $m=0$, the limits of c are found to be $c>0$ and $c=10$.

The conditions of the problem have each of the lads ascend *part* of the way *before* resting and the remainder of the way *after* resting. The values $m=0$, $p=20$, and $c=10$, do, therefore, not apply to this problem. According to the conditions of the problem the limits of m are $m>0$ and $m<4$, and the limits of c are $c>0$ and $c<10$.

When $m=1$, c may have any value between $c>2$ and $c=9\frac{1}{2}$,
When $m=2$, c .. .. $c>4$ and $c=9$,
When $m=3$, c .. .. $c>6$ and $c=8\frac{1}{2}$,
When $m=\frac{1}{2}$, c .. .. $c>1$ and $c=9\frac{3}{4}$,
When $m=1\frac{1}{2}$, c .. .. $c>3$ and $c=9\frac{1}{4}$, &c., &c.

We accordingly observe that there may be many *sets* of *values* for the distances climbed and rates of speed; the number of *sets* and the *values* being restricted only by the limits of m and c.

To find the distances climbed by each before and after resting and the rates of speed, we have the following formulae and conditions:

m may have any value between $m>0$ and $m<4$.

c may have any value between $c>2m$ and $c=10-\frac{m}{2}$, the value of c depending on m, except that we know that the limits of c are $c>0$ and $c<10$.

$n=m+c$, $p=m+2c$, $y=1-\frac{2m}{c}$, and $x=\frac{40}{c}+y$ or $\frac{40-2m}{c}+1$; and mx, nx, and px are respectively the distances which A, B, and C ascend *before* resting.

We will now solve for a few sets of values.

Put $m=1$; then $c=$ any value between $c>2$ and $c=9\frac{1}{2}$.

Put $c=3$; then $n=4$, $p=7$,
$x=13\frac{2}{3}$ and $y=\frac{1}{3}$;
$\therefore$ $mx=13\frac{2}{3}$, $nx=54\frac{2}{3}$, and $px=95\frac{2}{3}$

Put $c=4$; then $n=5$, $p=9$
$x=10\frac{1}{2}$ and $y=\frac{1}{2}$;
$\therefore$ $mx=10\frac{1}{2}$, $nx=52\frac{1}{2}$, and $px=94\frac{1}{2}$.

Put $c=8$; then $n=9$, $p=17$,
$x=5\frac{3}{4}$, and $y=\frac{3}{4}$;
$\therefore$ $xm=5\frac{3}{4}$, $nx=51\frac{3}{4}$, and $px=97\frac{3}{4}$.

Put $m=2$; then c=any value between $c>4$ and $c=9$.
Put $c=6$; then $n=8$, $p=14$,
$x=7$ and $y=\frac{1}{3}$;
$\therefore$ $mx=14$, $nx=56$, and $px=98$.

Put $c=8$;, then $n=10$, $p=18$,
$x=5\frac{1}{2}$ and $y=\frac{1}{2}$;
$\therefore$ $mx=11$, $nx=55$, and $px=99$.

Put $c=7\frac{1}{2}$; then $n=9\frac{1}{2}$, $p=17$,
$x=5\frac{4}{5}$ and $y=\frac{7}{15}$;
$\therefore$ $mx=11\frac{3}{5}$, $nx=55\frac{1}{10}$, and $px=98\frac{3}{5}$.

Put $m=3$; then c= any value between $c>6$ and $c=8\frac{1}{2}$.
Put $c=7$; then $n=10$, $p=17$,
$x=5\frac{6}{7}$ and $y=\frac{1}{7}$;
$\therefore$ $mx=17\frac{4}{7}$, $nx=58\frac{4}{7}$, and $px=99\frac{4}{7}$.

Put $m=\frac{1}{2}$; then c=any value between $c>1$ and $c=9\frac{3}{4}$.
Put $c=2$; then $n=2\frac{1}{2}$, $p=4\frac{1}{2}$,
$x=20\frac{1}{2}$ and $y=\frac{1}{2}$;
$\therefore$ $mx=10\frac{1}{4}$, $nx=51\frac{1}{4}$, and $px=92\frac{1}{4}$.

Put $c=8$; then $n=8\frac{1}{2}$, $p=16\frac{1}{2}$,
$x=5\frac{7}{8}$ and $y=\frac{7}{8}$;
$\therefore$ $mx=2\frac{15}{16}$, $nx=49\frac{15}{16}$, and $px=96\frac{15}{16}$.

Hence, by assigning to m any value found within its limits, and finding the limits of c with reference to the respective values of m, the *sets of values* for x, y, mx, nx, and px are almost numberless. It will, however, be observed that all the values of m, except 1, 2, and 3, are fractional.

Another method of solution is the use of a *multiplier* instead of a *difference* in the relations of m, n, and p.

Put $n=am$; then $p=m(2a-1)$, $\frac{n+m}{n-m}=\frac{a+1}{a-1}$, $y=\frac{a-3}{a-1}$, and $x=\frac{40}{m(a-1)}+y$.

As previously stated, $\frac{n+m}{n-m}<2$; therefore $\frac{a+1}{a-1}<2$; whence $a>3$.

Substituting 20 for p in $p=m(2a-1)$, we find $a=\frac{10}{m}+\frac{1}{2}$.

Hence the limits for a are $a>3$ and $a=\frac{10}{m}+\frac{1}{2}$.

To show the process of work, we will solve for a few *sets of values*.

Put $m=1$; then a=any value between $a>3$ and $a=10\frac{1}{2}$.
Put $a=4$; then $n=4, p=7$,
$x=13\frac{2}{3}$ ane $y=\frac{1}{3}$;
$\therefore$ $mx=13\frac{2}{3}$, $nx=54\frac{2}{3}$, and $px=95\frac{2}{3}$.

Put $m=2$; then a=any value between $a>3$ and $a=5\frac{1}{2}$.
Put $a=4$; then $n=8, p=14$,
$x=7$ and $y=\frac{1}{3}$;
$\therefore$ $mx=14$, $nx=56$, and $px=98$.

For want of space, we will let the reader solve for sets of values when $m=0$, $m>4$, and $a<3$. The discussion of these values may prove interesting.

Also solved by *H. W. DRAUGHON.*

13. Proposed by H. C. WHITAKER, B. S., M. E., Professor of Mathematics, Manual Training School, Philadelphia, Pennsylvania.

Six city boys, Jim, Josh, Jerry, Jack, Jake and Jeorje went into the country to steal apples from a tree. While three kept watch, the other three climbed up and got what they wanted. Then they came down while the other three rascals went up and stole. The one that got most was one of 'the last to go up.

Each trio of theives took the same number and had each boy taken as many as he did take in *each of that number of pockets*, each trio would also have taken the same number and the tree would have lost 538 apples. As it was, Josh got more than Jack, but Jeorje got as many as Josh and Jack together, while Jake got twice as many as Jerry and two more than Jim. What were the names of the three that first kept watch?

Solution by H. W. DRAUGHON, Clinton, Louisana.

Let x= Jack's share, y= Josh's share and z=Jerry's share. Then from the conditions, $x+y$=Jeorje's share, $2z$=Jake's share, and $2z-2$=Jim's share. To find each share in integers, we must separate $\frac{1}{2}\times538=269$,—the numbers each trio would have taken,had the number in each share been squared, into 2 sets of 3 square numbers the sum of the roots in the two sets being equal. We easily find the required numbers to be, $(13)^2$, $(8)^2$, $(6)^2$, and $(12)^2$, $(10)^2$, $(5)^2$. Since the greatest root is 13, the boys who took respectively 13, 8, and 6 apples compose the trio who first kept watch. Comparing our results with the expressions for each boy's share given above, we find,

First trio;—Jerry, Jeorje, and Josh; respective shares;—6, 13, 8. Second trio;—Jack, Jake, and Jim; respective shares;—5, 12, and 10.

$\therefore$ Jerry, Josh and Jeorje first kept watch.

Also solved by *A. L. FOOTE, H. C. WHITAKER*, and *G. B. M. ZERR.*

PROBLEMS.

21. Proposed by Professor J. F. W. SCHEFFER, A. M., Hagerstown, Maryland.

A tobacconist has two kinds of smoking tobacco, of which the price of the